

City Water and Wastewater Utilities Division Oklahoma City, Oklahoma

Affordable Large-Scale Sewer Line Replacement

OKC Abates SSOs by Taking The Long View

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Visit OKC's Website



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Introduction

The cost of replacing failing sewer pipes is a major concern among communities with older sanitary sewer collection systems. Many systems installed in the post-World War II years used readily-available unreinforced concrete and brick pipe for sewer construction. We now know that these materials, especially when installed in warm climates at shallow grade, can fall victim to hydrogen sulfide generation and corrosion. These unreinforced lines are also prone to collapse, leading to system blockages and sanitary sewer overflows (SSOs).

Oklahoma City (OKC) experienced this problem in the mid-1980s, when it became apparent that virtually the entire 2,200-mile sewer collection system required replacement. Reasoning that even with today's technological advances, no sewer pipes are built to last forever, Oklahoma City implemented a 100-year capital improvement cycle that will continue indefinitely. Under this program, the City replaces sewer lines at the rate of 1% per year, so that every 100 years, the system will be completely renewed. By spreading the \$600 million capital improvement cost over 100 years, the City is able to hold the annual cost to just over \$6 million, or about \$13 per resident.

PVC pipe is the replacement material of choice. It is affordable, flexible, and corrosion-resistant, and has proved its worth over the past 14 years. Since the system rehabilitation program began, the City has decreased the number of emergency SSO calls from hundreds per year to just 23 in the year 2000. During the same period, while the system actually grew 14%, wet weather flow to the treatment plants decreased slightly.

Regional Setting: Sprawling System on the Great Plains

Oklahoma City Capital Improvement Program Facts



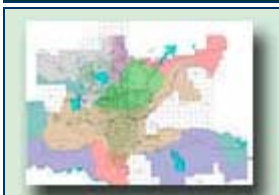
The system serves 506,000 people with 2,200 miles of sewers, 6,940 manholes, and 63 lift stations

OKC replaces 1% of sewer lines per year at a cost of \$13 per resident; total system replacement every 100 years

Based on home cleanup data, SSOs reduced from 173 in 1983 to 20 in 2000

Oklahoma City is in central Oklahoma's High Plains region. Its semi-arid climate features wide temperature extremes and sparse, unpredictable precipitation patterns. Because of the flat landscape, a large number of lift stations are needed to augment the flow within the gravity sewers. There are no receiving waters inside the collection system service area. Land use is primarily residential and commercial, with some agriculture.

Map of OKC's Sewer Collection System Service Area



Click on the image above to view OKC's sewer collection system service area.

The city's 620-square-mile incorporated area is home to 506,000 people. In comparison, Dallas, Texas, located 200 miles to the south, covers 378 square miles and has a population of 1.2 million. Oklahoma City's 320-square-mile sanitary sewer service area lies completely within the municipal boundary and serves approximately 96% of the population. The system contains 2,200 miles of sewer line, 63 lift stations, and four wastewater treatment plants with a combined capacity of 101 million gallons per day (mgd). The average dry weather flow to these plants is 75 mgd.

The sanitary sewer collection system is operated by the Oklahoma City Water and Wastewater Utilities Department (CWD) under the financial management of the Oklahoma City Water Utility Trust (OKWUT).

SSO History

In the mid 1980s, Oklahoma City faced widespread sanitary sewer line failures that led to almost daily sanitary sewer overflow (SSO) backups into homes and businesses. As the property damage mounted and customer satisfaction declined, the City looked to develop a solution that would quickly reduce the backups without burdensome rate hikes. The system needed a big-city overhaul on a small-city budget.

Most of the original cement, vitrified clay pipe, and ductile iron gravity sewers were installed in the 1940s, but a large number of lines were installed during a growth boom in the 1950s. The first failures occurred in this area, a donut-shaped region encircling the downtown area, and became more numerous during the 1980s. The vast majority of SSOs were caused by collapsed or breached lines, although a large number of blockages were also noted.

Most of the holes and collapses were found in concrete pipes that had prolonged exposure to corrosive hydrogen sulfide gas from stagnant or slow-flowing sewage. In some areas, ductile iron pipes fell victim to the region's naturally-occurring "hot" soils--highly acidic soils that ate through the metal. Many of the blockages resulted from grease plugs, root intrusions, and sediment buildup. The failures created openings that allowed excessive inflow and infiltration (I/I) to surcharge the system during wet weather, further

aggravating the backup problems.

CWD personnel logged hundreds of emergency calls per year from customers with sewage backups in their homes and businesses. Each time a call was received, a CWD crew was dispatched to the scene to investigate. If a CWD line failure or blockage was confirmed, the crew would respond to the problem as needed to stop the overflow and, if requested, assist the homeowner with basic cleanup. If the backup was determined to originate in the private service connection, the owner was advised to contact a contractor for assistance.

Between 1983 and 1987, CWD performed 805 home cleanups: an average of 161 per year. With so much effort focused on SSO response and home cleanups, CWD staff had little time for system evaluation, maintenance, or rehabilitation.

The demand for change came from CWD's customers, who let community leaders know they were willing to pay higher sewer bills or sacrifice other planned municipal projects, to have the system improved.

The Local Solution: Focus on Backup Prevention Through Sewer Line Replacement

Sewer Line Replacement

Beginning in 1986, CWD began replacing 22 miles per year of its sewer line, or 1% of the system. PVC pipe was chosen as the primary replacement material because of its resistance to hydrogen sulfide and soil corrosion, reasonable cost, and ease of installation.



The sections to be replaced are prioritized annually. Initially, tracking the number and distribution of home backups was the easiest and most reliable way to target sewer replacements. By 1991, the frequency and magnitude of backups had dropped off dramatically because the worst lines had been replaced. While backups are still tracked and analyzed, CWD now relies more on television surveillance, smoke and dye testing, and field reports from line maintenance crews, to identify problem lines.

CWD established design, construction, and inspection standards for new pipe installations. These standards help ensure that new lines remain corrosion-resistant, deflection-free, tightly connected at jointed and valved areas, and properly oriented to maximize gravity flow. Standards have been established for flexible pipes, such as PVC and ductile iron, and for new rigid pipes, such as concrete.

For PVC pipes, CWD adopted ASTM pipe stiffness, sewer connection and Class 1 bedding material requirements. These construction standards are designed to ensure that the pipe doesn't crack, buckle, or score during installation. The Class 1 requirements,

which call for a minimum of 12" of crushed rock for most lines, are not used in many cities. CWD believes the bedding protection is at least as important in preventing deflection as tensile strength or load calculation. This is particularly true in Oklahoma City, which is known for excessive soils movement and expansion.

Similar standards are in place for sliplined pipe replacements, designed to ensure that sewer flow is not interrupted, and that sliplined pipe doesn't crack, buckle, score, or leak during installation. These include specifications for insertion/access pits, sewer flow control, and liner pipe insertion, sealing, and grouting.

Contractor performance provisions include mandatory television inspection and videotaping, flow monitoring, deflection and leak testing, and two-year performance bonds for all new lines. Lines larger than 24" in diameter are also routinely inspected prior to acceptance by public works inspectors.

Throughout the sewer collection system industry in the late 1980s, there were doubts as to the long-term durability of PVC. It was predicted that excess deflection would result in early pipe failures; however, that has not been the case. In fact, a 1997 pilot study on a 10-year-old section of sliplined PVC revealed that the pipe had excellent structural integrity, water-tight joints, and no significant deflection.

Other Capital Improvements

In addition to the new pipe, CWD upgraded the wastewater treatment plants, installed new service mains, rehabilitated, replaced, or retired a number of lift stations, and completed an extensive manhole rehabilitation and replacement program.

As the community grows, the system also grows, at a rate of about 1% per year. When development comes to a basin that is not yet sewerred, CWD works with developers to design and install additional large-diameter PVC lines and/or lift stations for the entire basin, not just the proposed development. The developer and CWD split the cost of the new line. As development moves into the basin, CWD collects new sewer tap revenues to reimburse the contractor and itself for the up-front construction costs.

Preventive Maintenance

CWD has an established annual maintenance program that includes cleaning and maintaining at least 2,000 manholes per year, cleaning and maintaining at least 237 miles of line, and televising at least 75 miles of line. Since data tracking began in 1996, CWD has exceeded these maintenance goals every year.

Another maintenance goal has been to

OKC Sewer System Maintenance Program Accomplishments



identify global positioning system coordinates for all manholes in the system within 10 years. This activity, which started in 1996, is well ahead of schedule and will likely be completed in 2002.

Since CWD began tracking maintenance performance in 1996, program goals have been exceeded every year. Click on the image above to view performance statistics.

All maintenance activities are completed according to established performance standards. These activities help reduce and prevent blockage-related backups and identify failing or weakened structures so they can be included future maintenance, repair or replacement programs.

While most of these inspections are routine, about 5% are performed in response to identified backup problems. While most of these are solved with line cleaning, CWD also recognizes that some percentage of backups will require line repair or rehabilitation. For that reason, the O&M program includes a goal of repairing at least 2.85 miles of line per year. Since tracking began in 1996, CWD has repaired an average of 2.93 miles per year.

Fast and Effective Overflow Response

The primary focus of CWD's overflow response plan is speed. To minimize damage to the system and private property, personnel strive to respond to emergency calls in less than one hour, 45 minutes. Since data tracking began in 1996, this goal has consistently been achieved, even while the system and the community have continued to grow. Emergency crews are on hand 24 hours a day, seven days a week.

CWD follows up on every complaint with a site visit. The first action of the field crew is to televise the section of sewer line where the backup occurred. This allows the crew to assess the extent of the problem, and to determine whether it can be effectively addressed with maintenance. Once the problem has been diagnosed, CWD moves into high gear to respond to the problem.

Responses performed by CWD personnel include needed maintenance, minor repairs, blockage removal, and, in the case of a failed line, emergency bypassing of the sewage until the line can be replaced. Line blockages are the most frequent cause of backups, typically caused by root balls, grease plugs, and faulty plumber taps to sewer lines.

Line replacements are performed by private contractors. CWD has a pre-approval and standardized bidding process that can get a contractor on the job within 72 hours. Use of pre-approved contractors also builds expertise within the contracting community and cuts down on installation errors.

OKC Sewer System Emergency Response Time



Rapid SSO response reduces property damage and allows CWD crews to quickly implement a solution. Click above to see response time statistics for 1996-2000.

Information Management

CWD has developed an integrated geographic information system (GIS) for its sewer system. Data collected during routine maintenance are combined with existing sewer map information and building footprints to document line and manhole locations. This system is linked to the billing, budgeting, operations and maintenance, and complaint-tracking systems. This integration allows CWD to maintain up-to-date analyses of backup patterns and quickly develop response strategies. It also allows integration of sewer system data with other city infrastructure, including water and energy utilities.

Focus on Customer Service

Since the collection system rehabilitation project began, CWD has dramatically improved its relationship with its customers. This change came from a new dedication to customer service that underscores all other aspects of the program. Before the project, customer contact with CWD was typically limited to emergency situations and billing questions.

Today, CWD has established a working partnership with its customers, by making a point of listening to their concerns and answering their questions. In return, customers are more receptive to CWD requests, such as proper disposal of oil and grease and root ball reduction through better landscaping.

All CWD personnel undergo customer service training. This helps them understand customers' point of view and concerns, answer questions, and recognize and use opportunities, such as emergency calls, to provide education and outreach that will help avoid problems in the future.

CWD has increased access to its informational resources through a 24-hour emergency hot line, customer information desk, internet pages with answers to frequently asked questions, and topical printed material. OKWUT also produces annual reports on the water and wastewater treatment system performance, improvements, and finances. These reports are inserted into customer bills.

Cost and Funding

Long-Term Planning Reduces Financial Burden

As of 2001, CWD and OKWUT have spent approximately \$84 million on the sewer system rehabilitation. By 2086, the total price tag for the program is expected to amount to almost \$1 billion, yet the cost to customers has been held to about \$13 per person, or about \$6 million per year.

Enterprise Fund Structure Helps Stabilize Revenue and Planning

CWD knew the program could not be successfully implemented within the municipal general fund accounting structure. For several

years in the early 1980s, planned capital improvements were delayed due to lack of funds, even though adequate revenues were being collected through monthly sewer bills and new connection fees. These revenues were pooled with other city revenues in the general fund, which was then appropriated to cover most municipal programs and projects. CWD's annual expenses were budgeted relative to all other municipal programs, and some of its revenues were used to fund other projects, such as road and park improvements.

Another problem was an Oklahoma state law that prohibits municipalities from retaining funds for longer than a year. This limitation prevented development of long-term capital plans or necessary reserve funds.

In 1986, OKWUT was established by the city manager as an enterprise trust. OKWUT provides the financing and management structure needed to create long-term solutions for the City's sanitary sewer, wastewater treatment, and drinking water systems. OKWUT operates like a profit-generating business, collecting and disbursing sewer system revenues to pay day-to-day program expenses and fund long-term capital improvements. It has the power to assume debt as needed and to invest annual profits on behalf of CWD. OKWUT also has the power to assess the adequacy of sewer rate structures and to request increases when needed.

Since 1986, OKWUT has approximately doubled CWD's annual operating budget, through gradual rate increases and bond issuances.

Results

CWD's capital improvement and maintenance programs have been effective in reducing SSOs. Since most SSOs in Oklahoma City affect private property, CWD tracks success in terms of the number of claims from private property owners who have experienced sewer backups caused by problems with the sewer collection system. As shown in the graph, the annual number of claims has declined from 1173 in 1983 to 20 in 2000 - an 80% improvement.

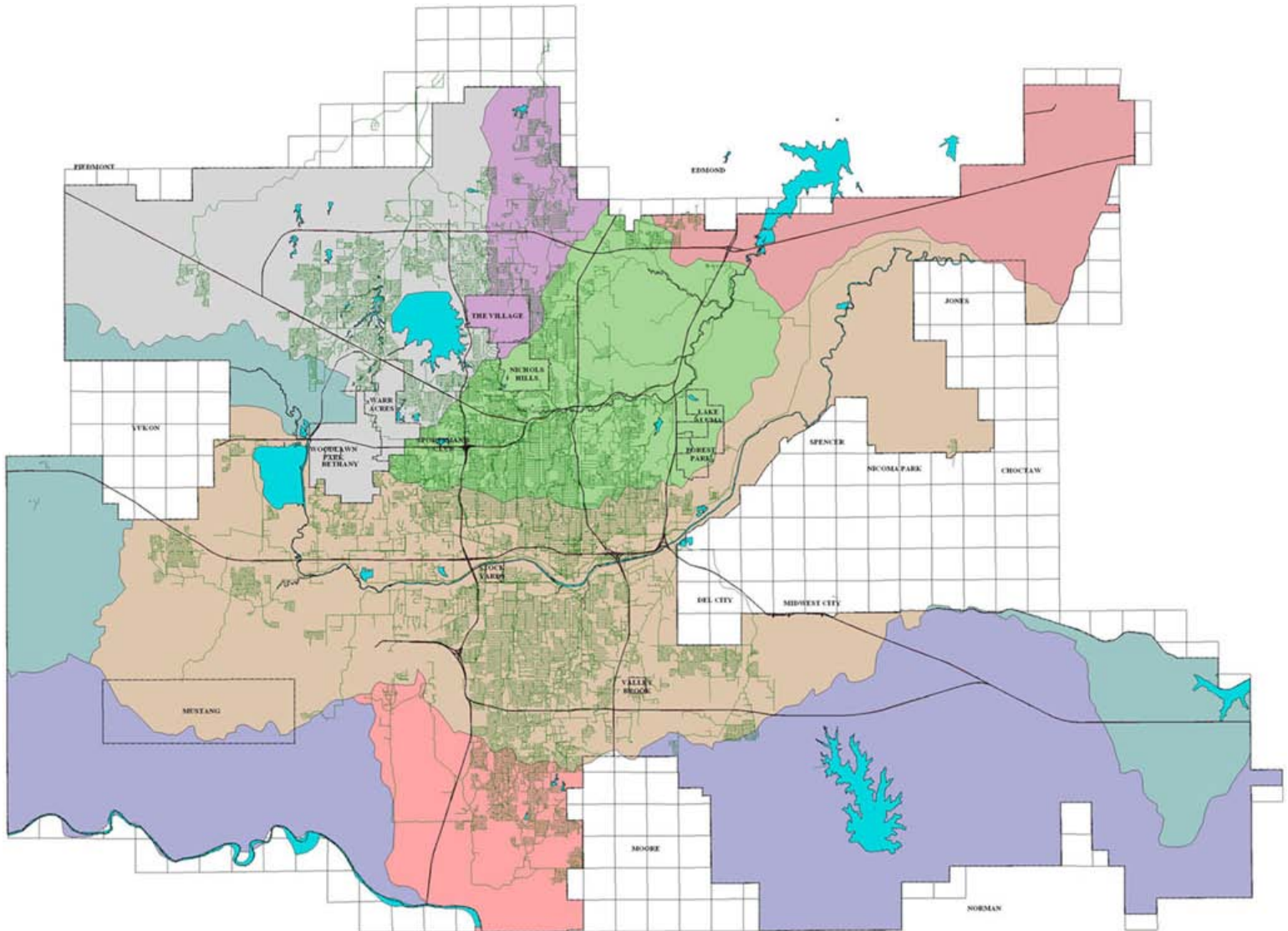


For More Information

Visit CWD's website at <http://www.okc.gov/> to learn more about CWD and to obtain contact information.

Oklahoma City's Sewer Collection System

Oklahoma City's 320-square-mile sanitary sewer service area lies completely within the 620-square-mile municipal boundary and serves about 96% of the population. The 2,200 miles of sewer line are shown by the dark green lines. [Click here](#) for the map legend.



Legend

-  Highways
-  OKC City Limit Boundary
-  Wastewater CIP (Since 1987)
-  Wastewater Collection System
-  Lakes

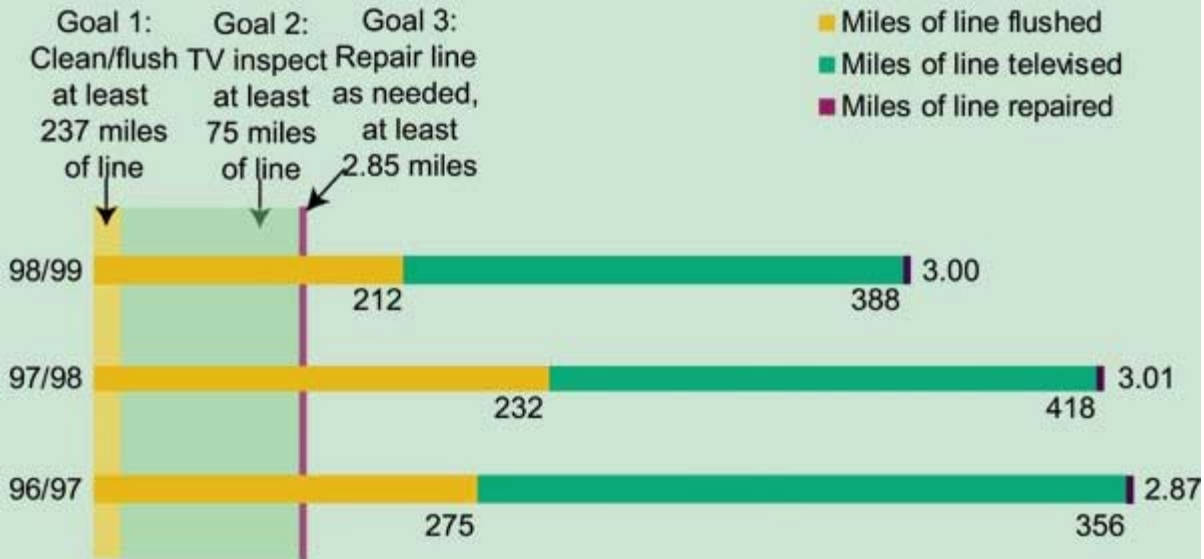


Water & Wastewater Utilities Department
Infrastructure Management Section

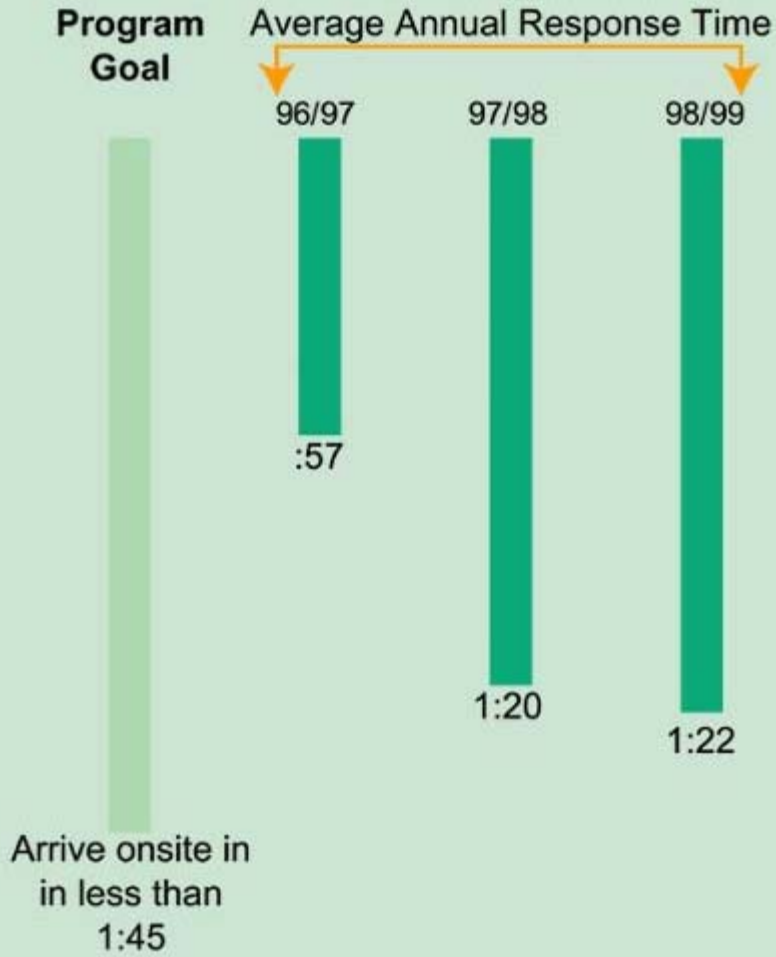
Manhole Maintenance



Sewer Line Maintenance



Average Time to Respond to Sewer Backup Emergency Calls (Hours: Minutes)



Number of Sewer Backup Claims Paid 1983 - 2000

